FIG. 1A

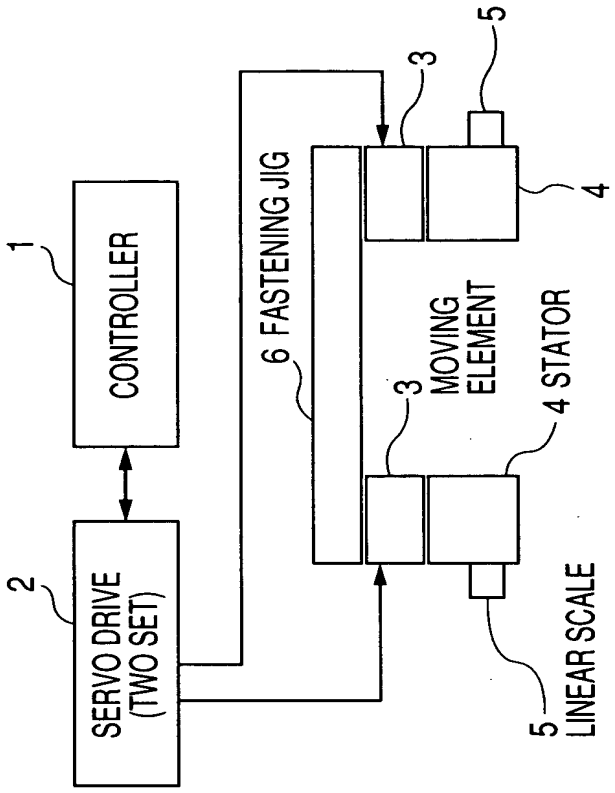


FIG. 1B

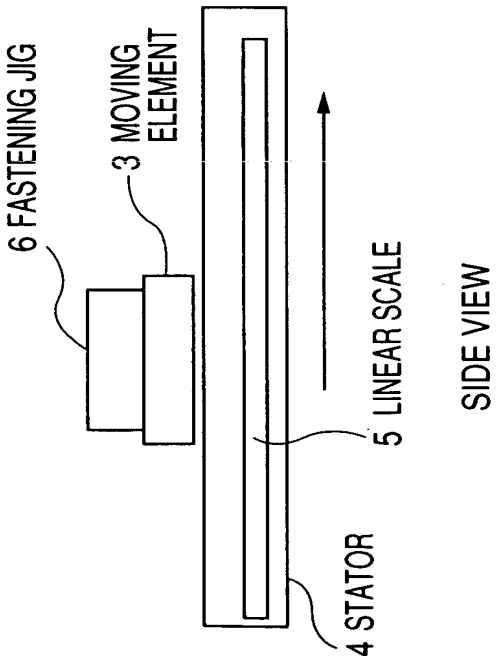
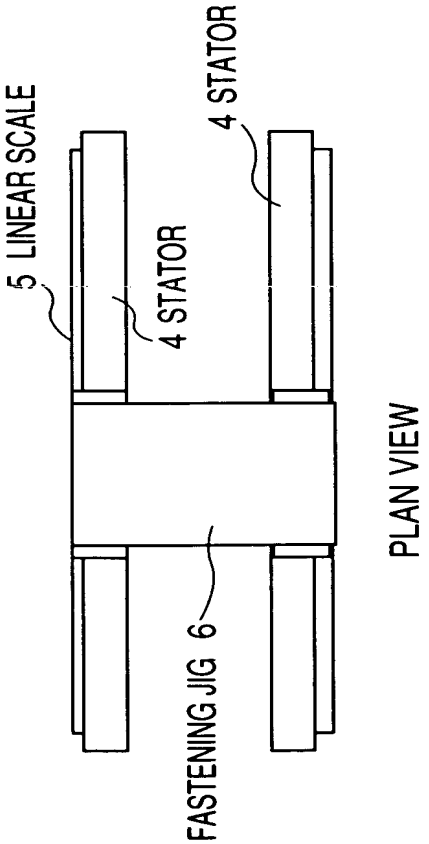


FIG. 1C



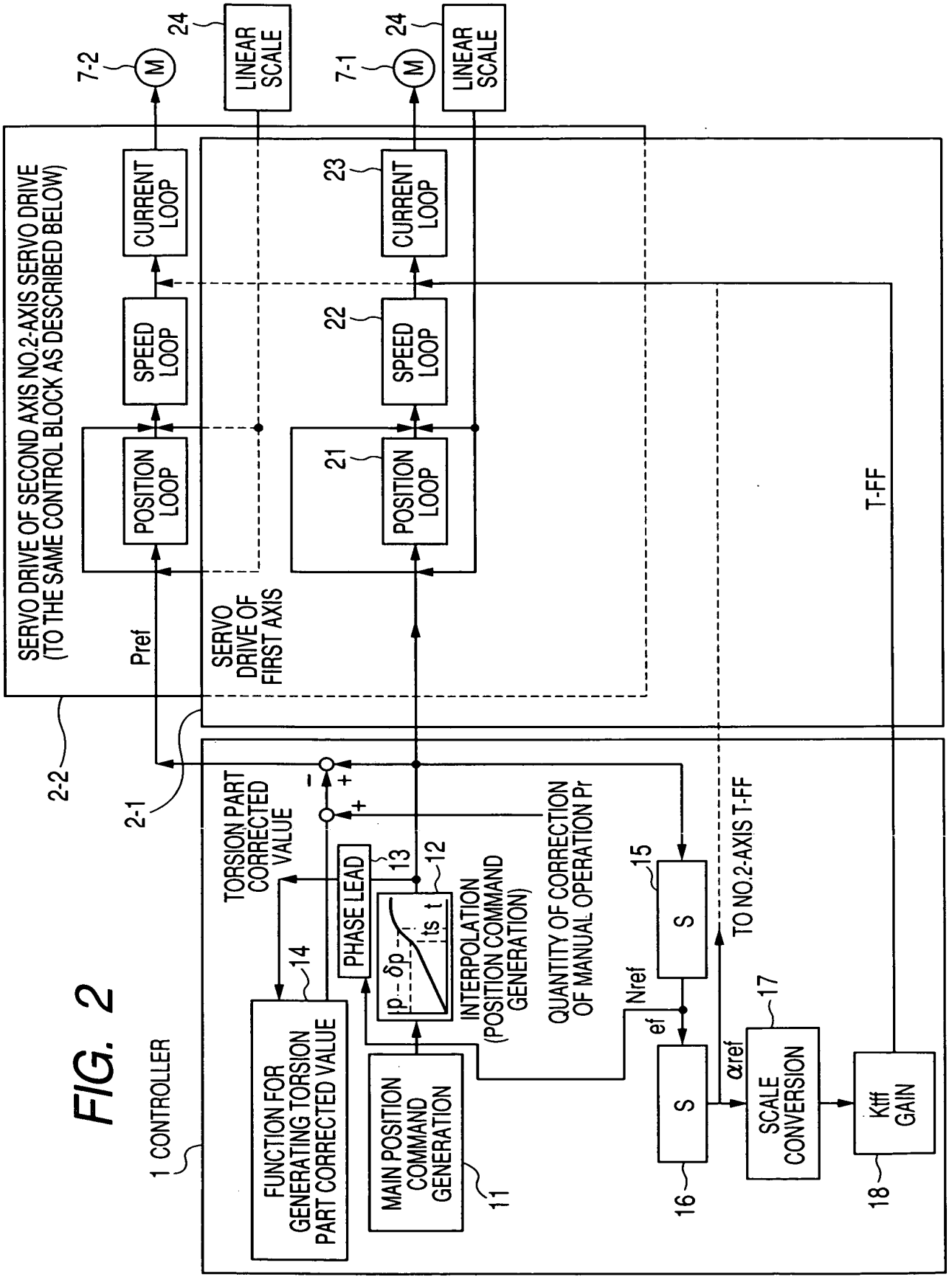

SERVO DRIVE OF SECOND AXIS NO.2-AXIS SERVO DRIVE
(TO THE SAME CONTROL BLOCK AS DESCRIBED BELOW)
SERVO DRIVE OF FIRST AXIS
7-2
7-1
M
24
LINEAR SCALE
CURRENT LOOP
SPEED LOOP
POSITION LOOP
23
22
21
T-FF
Pref
2-2
2-1
1 CONTROLLER
TORSION PART CORRECTED VALUE
PHASE LEAD
13
12
INTERPOLATION (POSITION COMMAND GENERATION)
QUANTITY OF CORRECTION OF MANUAL OPERATION Pr
15
S
Nref
ef
TO NO.2-AXIS T-FF
17
αref
SCALE CONVERSION
Ktff GAIN
18
16
14
FUNCTION FOR GENERATING TORSION PART CORRECTED VALUE
MAIN POSITION COMMAND GENERATION
11

FIG. 2

FIG. 3

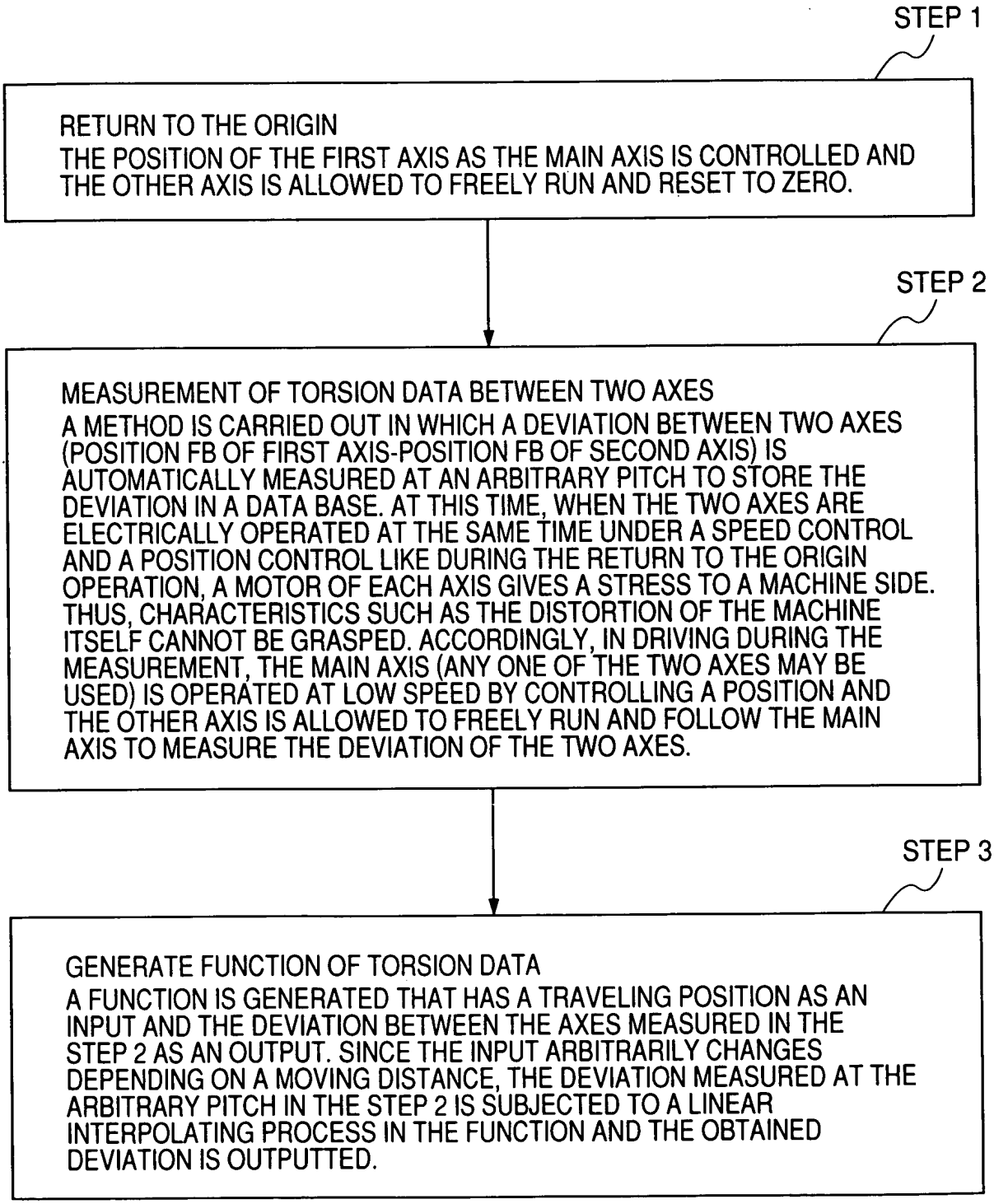

STEP 1
RETURN TO THE ORIGIN
THE POSITION OF THE FIRST AXIS AS THE MAIN AXIS IS CONTROLLED AND THE OTHER AXIS IS ALLOWED TO FREELY RUN AND RESET TO ZERO.
STEP 2
MEASUREMENT OF TORSION DATA BETWEEN TWO AXES
A METHOD IS CARRIED OUT IN WHICH A DEVIATION BETWEEN TWO AXES (POSITION FB OF FIRST AXIS-POSITION FB OF SECOND AXIS) IS AUTOMATICALLY MEASURED AT AN ARBITRARY PITCH TO STORE THE DEVIATION IN A DATA BASE. AT THIS TIME, WHEN THE TWO AXES ARE ELECTRICALLY OPERATED AT THE SAME TIME UNDER A SPEED CONTROL AND A POSITION CONTROL LIKE DURING THE RETURN TO THE ORIGIN OPERATION, A MOTOR OF EACH AXIS GIVES A STRESS TO A MACHINE SIDE. THUS, CHARACTERISTICS SUCH AS THE DISTORTION OF THE MACHINE ITSELF CANNOT BE GRASPED. ACCORDINGLY, IN DRIVING DURING THE MEASUREMENT, THE MAIN AXIS (ANY ONE OF THE TWO AXES MAY BE USED) IS OPERATED AT LOW SPEED BY CONTROLLING A POSITION AND THE OTHER AXIS IS ALLOWED TO FREELY RUN AND FOLLOW THE MAIN AXIS TO MEASURE THE DEVIATION OF THE TWO AXES.
STEP 3
GENERATE FUNCTION OF TORSION DATA
A FUNCTION IS GENERATED THAT HAS A TRAVELING POSITION AS AN INPUT AND THE DEVIATION BETWEEN THE AXES MEASURED IN THE STEP 2 AS AN OUTPUT. SINCE THE INPUT ARBITRARILY CHANGES DEPENDING ON A MOVING DISTANCE, THE DEVIATION MEASURED AT THE ARBITRARY PITCH IN THE STEP 2 IS SUBJECTED TO A LINEAR INTERPOLATING PROCESS IN THE FUNCTION AND THE OBTAINED DEVIATION IS OUTPUTTED.

FIG. 4

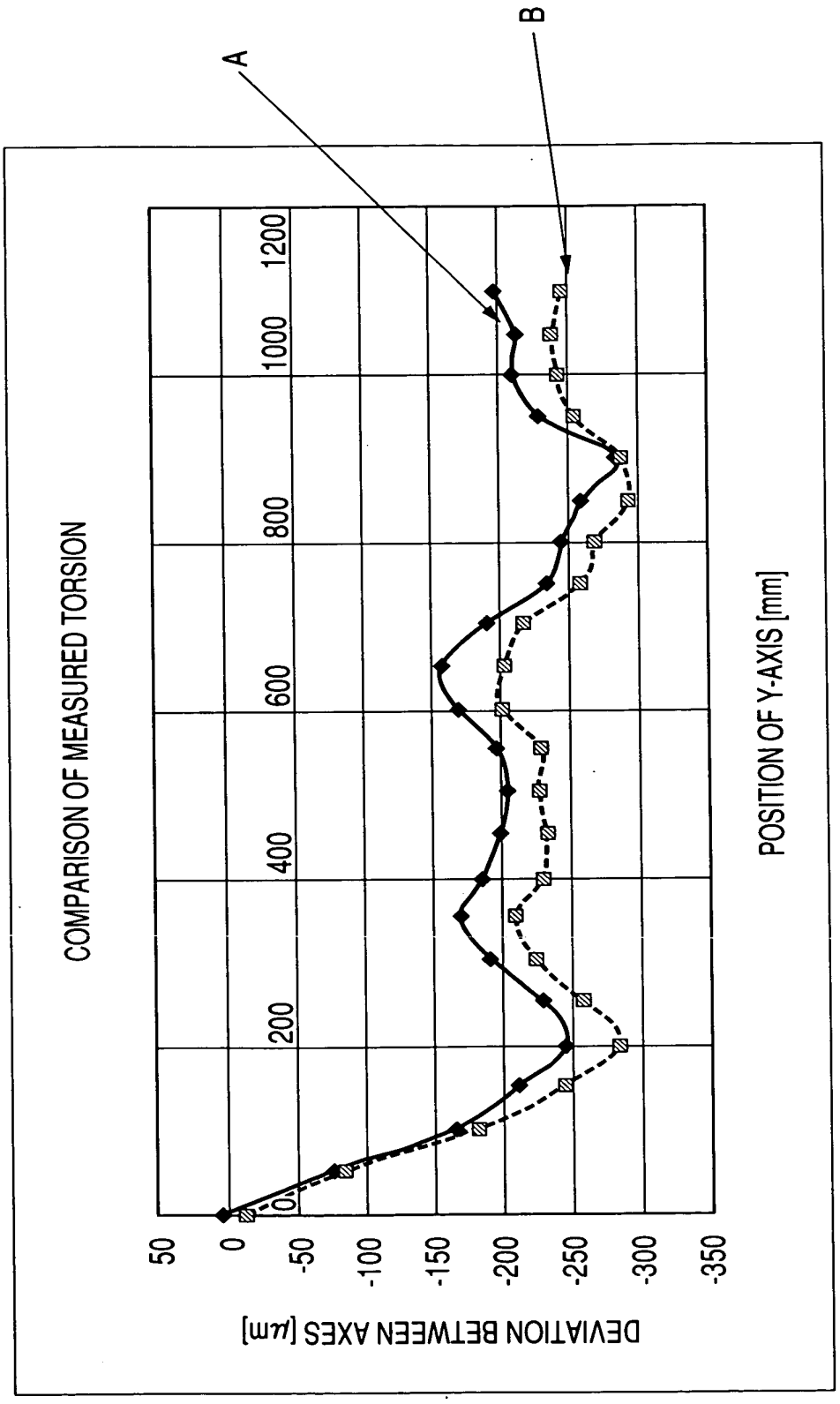

COMPARISON OF MEASURED TORSION
A
B
DEVIATION BETWEEN AXES [μm]
50
0
-50
-100
-150
-200
-250
-300
-350
0
200
400
600
800
1000
1200
POSITION OF Y-AXIS [mm]
A: MEASURED VALUE BY LASER DISPLACEMENT GAUGE
B: MEASURED VALUE BY CONTROLLER

FIG. 5

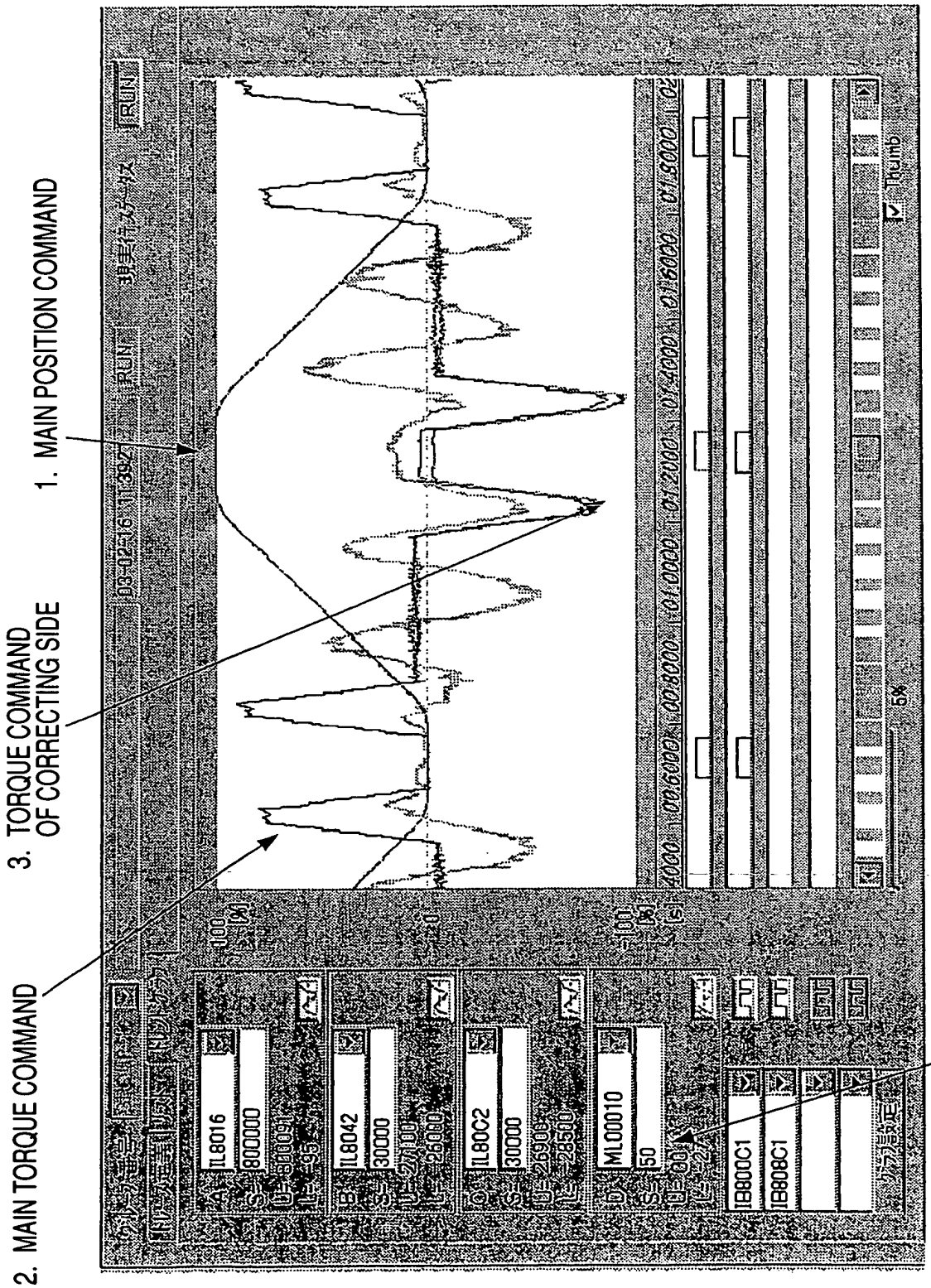

1. MAIN POSITION COMMAND
2. MAIN TORQUE COMMAND
3. TORQUE COMMAND OF CORRECTING SIDE
4. DEVIATION BETWEEN TWO AXES (MAXIMUM VALUE OF 30μm)
RUN
03-02-16 11:39:27
IL8016
IL8042
IL80C2
ML00010
IB800C1
IB808C1

FIG. 6

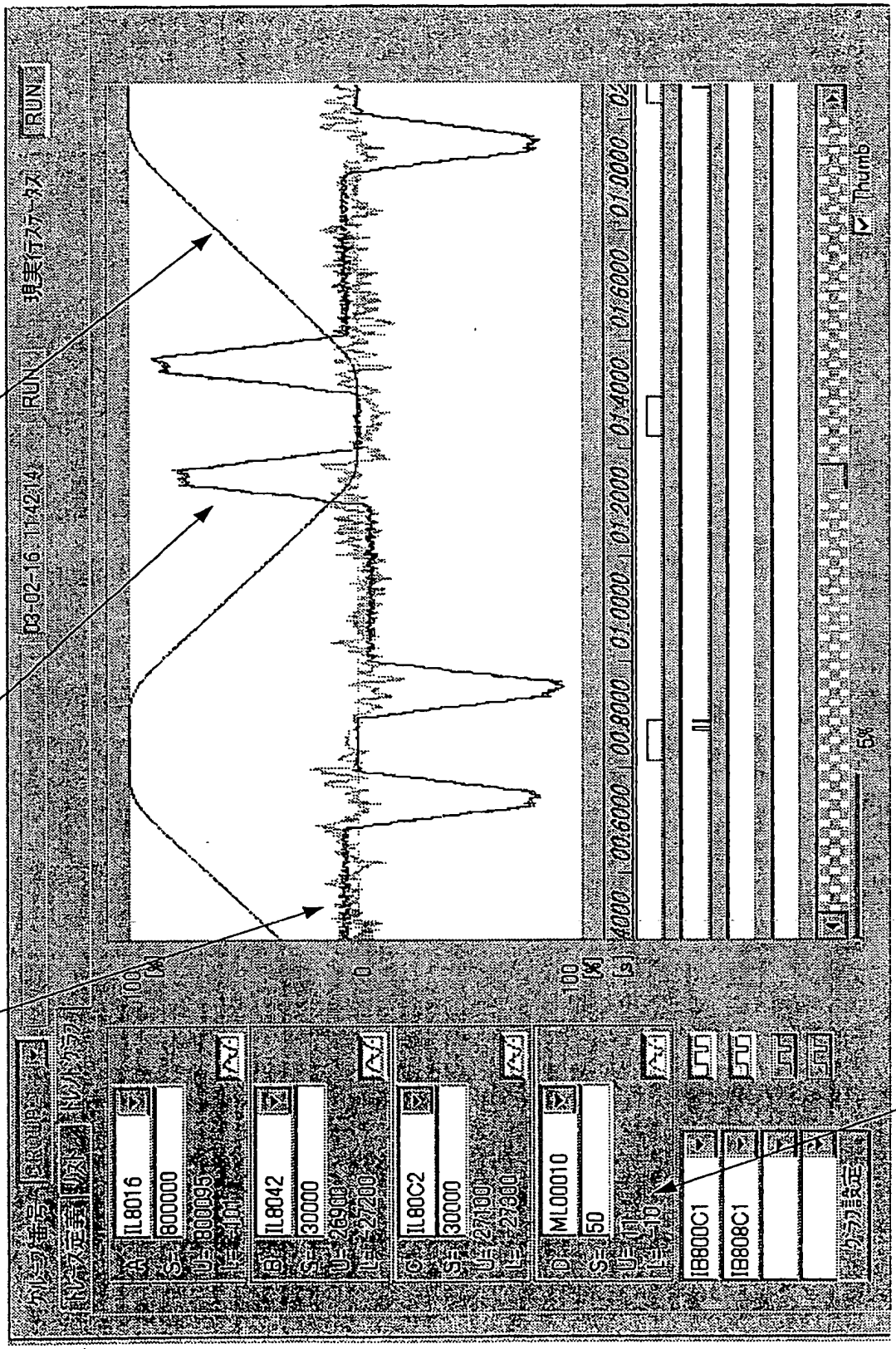

1. MAIN POSITION COMMAND
2. MAIN TORQUE COMMAND
3. TORQUE COMMAND OF CORRECTING SIDE
4. DEVIATION BETWEEN TWO AXES (MAXIMUM VALUE OF 11μm)
RUN
03-02-16 11:42:14
Thumb

FIG. 7

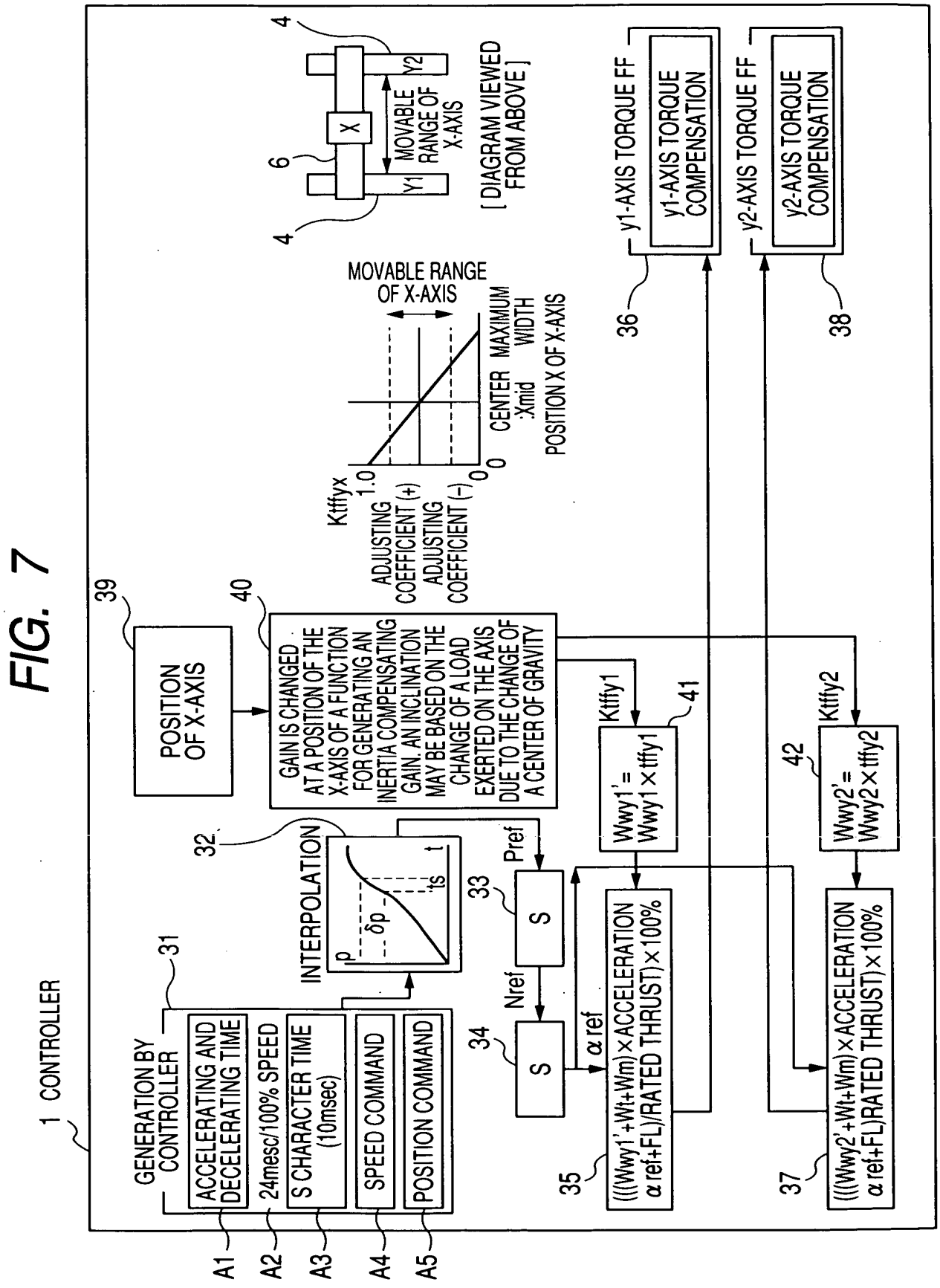

1 CONTROLLER
GENERATION BY CONTROLLER
ACCELERATING AND DECELERATING TIME
24msec/100% SPEED
S CHARACTER TIME (10msec)
SPEED COMMAND
POSITION COMMAND
31
A1
A2
A3
A4
A5
INTERPOLATION
32
P
δp
ts
t
Pref
Nref
S
33
34
α ref
(((Wwy1'+Wt+Wm)×ACCELERATION α ref+FL)/RATED THRUST)×100%
35
Wwy1'= Wwy1×tffy1
41
Kffy1
(((Wwy2'+Wt+Wm)×ACCELERATION α ref+FL)/RATED THRUST)×100%
37
Wwy2'= Wwy2×tffy2
42
Kffy2
y1-AXIS TORQUE FF
y1-AXIS TORQUE COMPENSATION
36
y2-AXIS TORQUE FF
y2-AXIS TORQUE COMPENSATION
38
39
POSITION OF X-AXIS
40
GAIN IS CHANGED AT A POSITION OF THE X-AXIS OF A FUNCTION FOR GENERATING AN INERTIA COMPENSATING GAIN. AN INCLINATION MAY BE BASED ON THE CHANGE OF A LOAD EXERTED ON THE AXIS DUE TO THE CHANGE OF A CENTER OF GRAVITY
MOVABLE RANGE OF X-AXIS
Kffyx
1.0
ADJUSTING COEFFICIENT (+)
ADJUSTING COEFFICIENT (-)
0
0
CENTER :Xmid
MAXIMUM WIDTH
POSITION X OF X-AXIS
4
6
X
Y1
Y2
MOVABLE RANGE OF X-AXIS
[DIAGRAM VIEWED FROM ABOVE]

FIG. 8

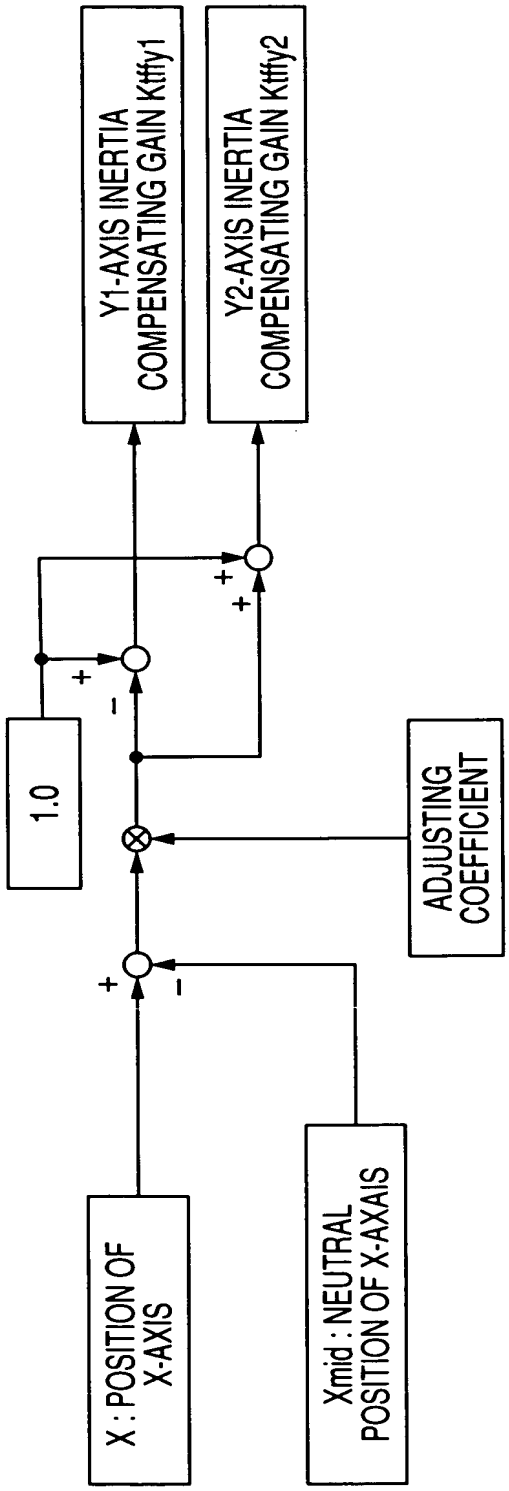

Y1-AXIS INERTIA COMPENSATING GAIN Kffy1
Y2-AXIS INERTIA COMPENSATING GAIN Kffy2
1.0
ADJUSTING COEFFICIENT
X : POSITION OF X-AXIS
Xmid : NEUTRAL POSITION OF X-AXAIS
+
-
+
+
+
-
+
-

FIG. 9

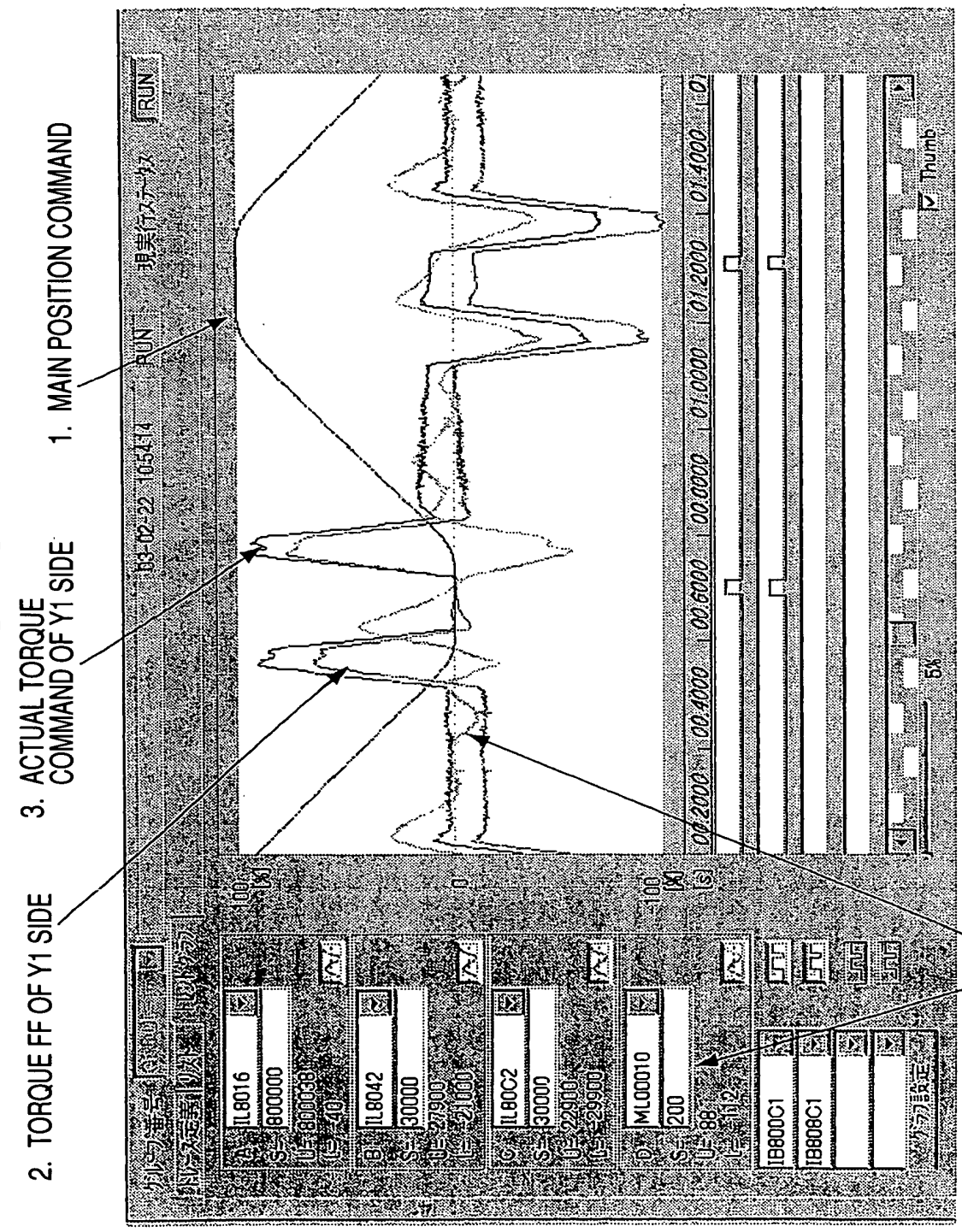
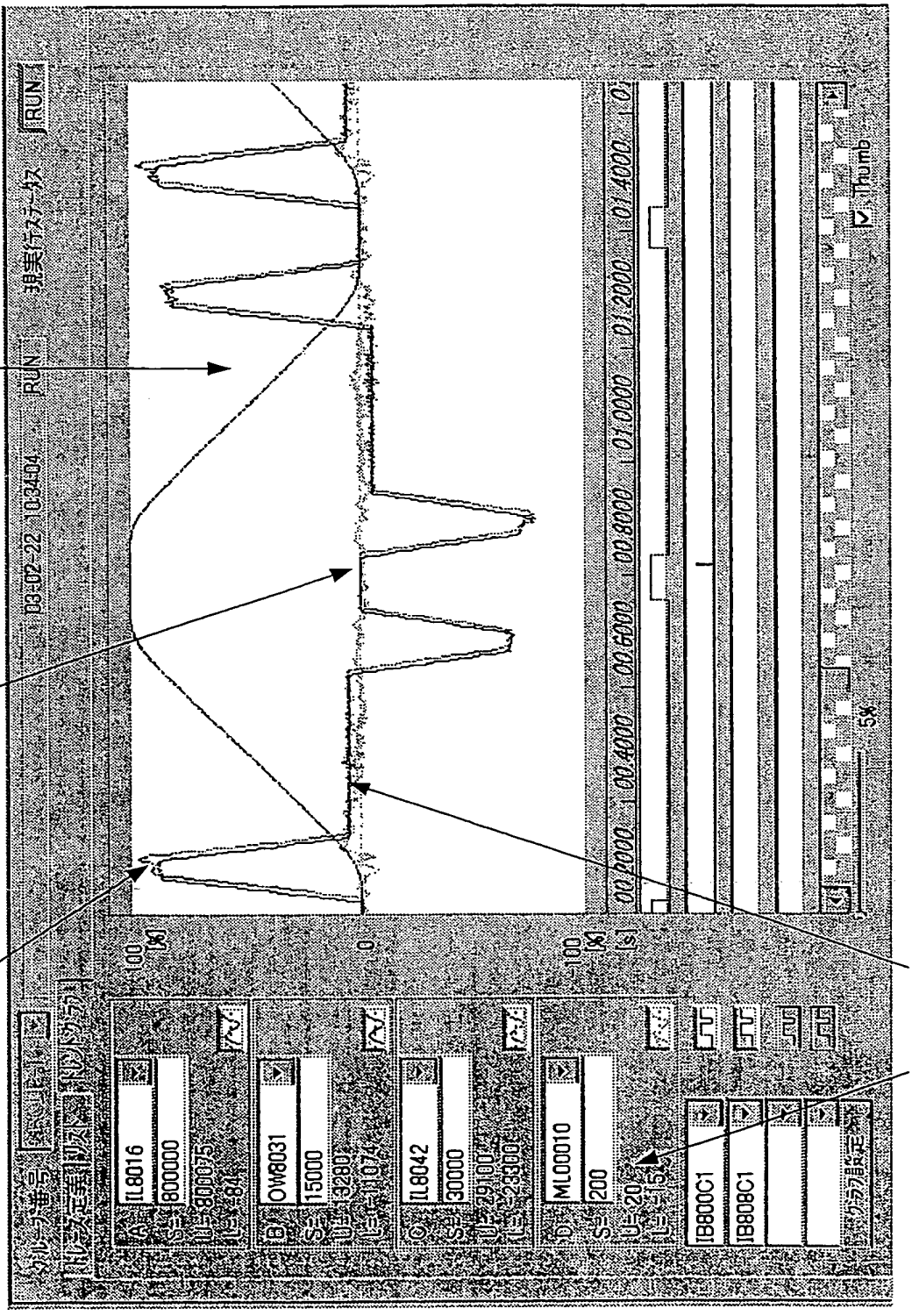

1. MAIN POSITION COMMAND
2. TORQUE FF OF Y1 SIDE
3. ACTUAL TORQUE COMMAND OF Y1 SIDE
4. DEVIATION BETWEEN TWO AXES (MAXIMUM VALUE OF 112μm)
RUN
Thumb

FIG. 10


1. MAIN POSITION COMMAND
2. TORQUE FF OF Y1 SIDE
3. ACTUAL TORQUE COMMAND OF Y1 SIDE
4. DEVIATION BETWEEN TWO AXES (MAXIMUM VALUE OF 20μm)
RUN
03-02-22 10:34:04
IL8016
IL8042
IB800C1
IB808C1
Thumb